Influence of Temperature on Absorption Spectra of Novel $TlGa_{1-x}Fe_xSe_2$ Single Crystals

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The search for new semiconductor materials is one of the cardinal problems of modern solid-state physics and crystallochemistry. Revealing new materials along with the extension of scientific knowledge opens new properties: As a rule, new substances, especially with chain-layered structure, show new properties and require the solution of new technical problems.

The aim of the present work is to treat the influence of temperature and partial substitution of *Ga* ions in layer $TlGaSe_2$ single crystals by *Fe* ions on optical properties.

Layer $TlGaSe_2$ single crystals doped with *Fe* were grown by the Bridgeman-Stockbarger method.

Microprobe analysis showed a good solubility of *Fe* in $TlGaSe_2$.

Measurements of absorption spectra of single crystals of $TlGa_{1-x}Fe_xSe_2$ (x=0; 0.005; 0.01) were carried out over the temperature range of 10-100K. The thickness of the investigated crystals was 10-100mkm. Non-polarized light flow under the investigation of absorption spectra is led perpendicularly to the natural layer of crystal. Study of absorption spectra showed that the structure of the absorption edge of investigated $TlGaSe_2$ and $TlGa_{1-x}Fe_xSe_2$ (x=0.005; 0.01) single crystals is similar. Absorption coefficient (α) of $TlGa_{1-x}Fe_xSe_2$ single crystals significantly increases with x increasing. Two exciton peaks (low-and high-energy) appeared in the absorption spectra of $TlGaSe_2$ and $TlGa_{1-x}Fe_xSe_2$ single crystals. Energy position of these exciton peaks depends on *Fe* concentration. The temperature dependence of the energy position of the high-energy exciton peak in $TlGa_{1-x}Fe_xSe_2$ crystals was investigated in the 10-80 K temperature range. Substitution of 1% of *Ga* atoms by *Fe* atoms in $TlGaSe_2$ single crystals brings about the shift of energy position of this high-energy exciton absorption peak to the long-wave side of spectrum. The average value of this energy shift is ΔE_1=2meV at all studied temperature ranges. Analogous dependences were observed for exciton absorption peak, related with direct transition (low-energy exciton peak). The dependence of the energetic position of low-energy exciton peak on *Fe* concentration (x) was investigated. It was shown that this dependence is linear. At x=0.01 value of this exciton peak shift is ΔE_2= 46meV at 20K.

Thus, doping of $TlGaSe_2$ single crystals by *Fe* leads to modification of their absorption spectra, change of exciton characteristics, i.e. allows optical properties to be controlled.